Self-Face Processing After and Before Neurofeedback in Youth with Varying Levels of Depressive Symptoms

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Introduction

- Major depressive disorder is a major risk and has high levels of recurrence in adolescents (1, 2).
  - Treatments only have moderate effects.
  - Depression will come back in most cases.
- It is important to have treatments to change neurobiology in order to have a better treatment for depression.
- Neurofeedback is a novel way to change brain activity in-vivo.
  - *Example: Watching a bar going up and down to represent activity from the hippocampus and amygdala.*
- Self-Referential processing is essential for development in adolescents (3)
- However, differences in response to negative emotion have been associated with vulnerability to suicidal behavior (4).
- In addition, negative self-image, a symptom of depression, has been found to lead depressed individuals to perceive negative information as relevant to themselves (5).

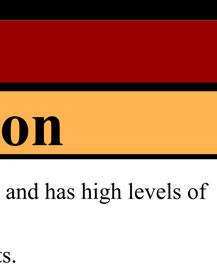
Research Question: Does self-processing (self-face versus other-face) change neurobiology after a neurofeedback trial in adolescents with depression?

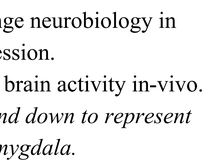
Methods

Session 1:
All participants were given a **psychological interview** to assess symptoms of depression.

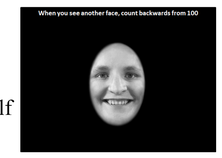
Session 2:

1. **Emotional Self Other Morph - Pre (ESOM_Pre): Facial Recognition Task**
   a. Test consisted of morphs between their own face and a stranger's face.
   b. Had to determine whether the face they were seeing was their own face or another's.
2. **Neurofeedback Task**
   a. Participants then looked at their own happy face and recalled their happy memories.
   b. While looking at their own face, they received neurofeedback and had to increa the level of the bar (ie. brain activity) by recalling happy memories
   c. While looking at the stranger's face, th had to count backwards from 100
3. **ESOM_Post: Repeat Facial Recognition Test**





Statistical Tests:
A mixed repeated measure GLM (general linear model) examined brain activity with 3 within-subject factors: Time (Pre, Post) by Self (Self-face, Other-face) by Emotions (Happy, Neutral, Sad). The GLM was conducted through SPM 12.



Results

Table 1. Areas of Brain Activation During Self versus Other Face Processing

Whole-Brain Results	Voxels	Hemisphere	MNI Coordinates		
			x	y	z
Main Effect of Time[RW1]					
Cerebellum Posterior and Anterior Lobe	756	Both	2	-74	-20
Superior Temporal Gyrus, BA41	252	Left	-38	-30	4
Cuneus, Precuneus, Posterior Cingulate, Parahippocampa Gyrus	299	Left	-24	-50	6
Inferior Parietal Lobule, Caudate, Cingulate Gyrus, Anterior Cingulate, BA 40/44/24/9	2702	Left	-44	18	28
Middle Frontal Gyrus, Cingulate Gyrus, Precuneus, Caudate BA 6/7/5/40/4/3/32	3385	Left	-20	-20	48
Medial Frontal Gyrus/Cingulate Gyrus BA 6/32	571	Right	20	-18	54
Interaction of Time and Self[RW3]					
Middle and Medial Frontal Gyrus, Cingulate Gyrus, Anterior Cingulate, BA 9/6/32/10	1735	Left	-20	22	24
Superior and Medial Frontal Gyrus, BA 9	341	Right	10	36	42
Parietal Lobe, BA 6	186	Left	-14	-10	56

Table 1. Summary of Brain Region Locations With Significant Brain Activity. The table depicts the different brain regions with significant brain activity. It details which brain regions are active, the size of the region, the hemisphere it belongs to, and the coordinate of the most active cluster.

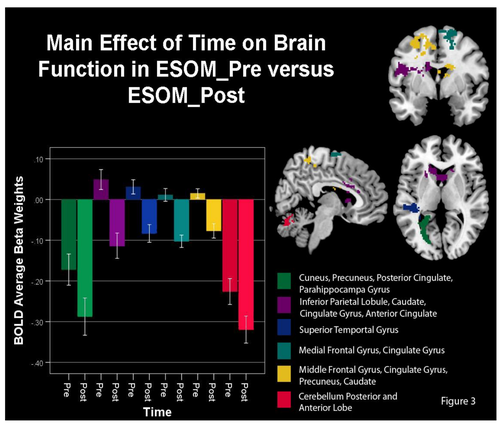


Figure 1. Main Effect of Time on Brain Function in ESOM_Pre Versus ESOM_Post Conditions. The brain activity of adolescents (n=52) was measured across several different cortical areas. To measure the activity, participants received an fMRI scan and completed the ESOM task. The activity before NF treatment (ESOM_Pre) and after NF (ESOM_Post) were compared to see how the treatment affected brain function in those areas. ($p<0.05$)

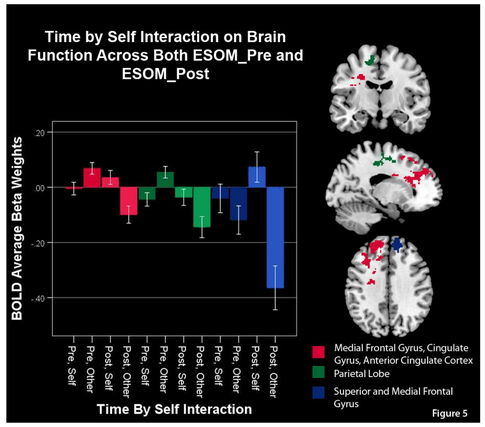


Figure 2. Effect of Time By Self Interaction on Brain Activity Across ESOM_Pre and ESOM_Post. The brain activity of adolescents (n=52) was measured across several different cortical areas. Facial recognition was compared across ESOM_Pre and ESOM_Post to see how the NF treatment affected the participants ability to recognize their own face.

Discussion & Limitations

- **Main Effect of Time**
  - More activity in ESOM_Pre than ESOM_Post in multiple cortical areas after the neurofeedback task (Table 1, Figure 1)
- **Time By Self Interaction**
  - Participants had more activity processing other faces than their own in ESOM_Pre. After neurofeedback treatment in ESOM_Post, they had more activity seeing their own face. These differences were seen in midline cortical areas known for self-referential areas (Table 1, Figure 2)
- The treatment was able to have a significant effect on brain function in several areas.
- **This suggests that neurofeedback might have had a significant effect on neurobiology**
- This suggests that the neurofeedback treatment could have **potential to act as a form of treatment** or a supplement to medication or psychotherapy to enhance recovery from depressive symptoms.
- This significant effect is interesting due to habituation (6).
  - Generally, ESOM_Pre should always have higher brain activity than ESOM_Post due to habituation.
- Because depression is so prevalent in adolescents and is a major risk factor in suicide, the study has important implications in the current public health crisis that is depression and suicide among adolescents
- **However, as there was no placebo group, it cannot be confirmed that these effects are due to neurofeedback.**

Participants

Table 2. Demographic Characteristics:

	Control	Low Suicidality	High Suicidality	Suicide Attempt
Participant Characteristics:				
Total: (n)	38	31	27	24
Age: (mean, stdv)	14.46, 1.52	14.87, 1.75	15.04, 1.68	14.61, 1.57
IQ (mean, stdv)	116.89 (12.30)	104 (14.44)	109.3 (12.56)	111.33 (21.64)
Gender (n, %)				
Male	19 (50)	14 (45)	12 (44)	10 (42)
Female	19 (50)	17 (55)	15 (56)	14 (58)
Medication (n, %)				
Antidepressants	2 (5)	10 (31)	13 (48)	13 (54)
Any Psychotropic	2 (5)	11 (35)	16 (59)	15 (63)

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